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ABSTRACT

This report of the results of an evaluation of computer operations at the University of Honduras (Universidad Nacional Autonoma de Honduras) begins by discussing the problem--i.e., poor utilization of the campus mainframe computer--and listing the hardware and software available in the computer center. Data collection methods are summarized, including interviews, budget examination, review of organizational structure, review of registration records and relevant documents, and on-site visits. The redefined problem, consisting of three primary areas, is described: (1) lack of a universal power system to serve as a back-up source during frequent electrical outages; (2) lack of a communications mechanism to the auxiliary campuses; and (3) lack of a computer operating system which supports commercial applications. In order to address these issues more fully, the development of the computer industry is reviewed, and it is proposed that the organizational structure operating philosophy be changed to reflect a more decentralized approach. An accounting system and improved inter- and intra-campus communications are recommended, as well as training of staff, creation of a department of computer science, increased space for the computer center, purchase of a universal power supply unit, and establishment of a university-wide database and word processor. The university is encouraged to take an advocacy role in national computer policy. (3 references) (MES)

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Utilization of Computer Technology in the Third World: An Evaluation of Computer Operations at the University of Honduras

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Abstract

This paper reports the results of an evaluation of computer operations at the Universidad Nacional Autonoma de Honduras (UNAH). Jointly co-sponsored by UNAH and the United States Information Service (in the United States: the United States Information Agency), the University's central administration was concerned that no significant use of the computer had been made in the two years since purchasing an IBM 4361, a mid-sized mainframe computer. This computer has the largest memory and computational capacity of any in Honduras and general expectations were that programs for it would quickly solve some of the enormous administrative tasks faced by the university. Jobs performed manually include registration (enrollment: 32,000 students), payroll (employees: 4,000), budgeting and auditing (approximately $30,000,000/year). In addition there was some concern that faculty made only minimal use of the computer, even though they had unlimited access to the machine.

Evaluation recommendations were directed towards implementing a strategy which would help the university change their operational philosophy and concomitant organizational structure. Recommendations included changing operating systems, decentralizing computer center operations, implementing alternative budgeting strategies, developing computer center and university training, and increasing access to the computer by faculty, students, and staff.

The evaluation demonstrated that the introduction of new technology is not complete unless it is integrated to all domains linked to the technology. These linkages can be far-reaching. Some may involve structures which are instituted to support the technology such as hardware maintenance, supply avenues, and distribution mechanisms. Other connections may be directly tied to the organization which uses the technology and the way political and economic power is distributed within the organization.

Introduction

The main campus of Universidad Autonoma Nacional de Honduras (UNAH) is located in Tegucigalpa[1], Honduras, and has an average enrollment of about 24,000 students. The auxiliary campuses are housed in San Pedro Sula[2] (enrollment of approximately 6,000 students) and La Ceiba (enrollment of approximately 1,600 students). Total enrollment, then, is about 32,000 students. Figure 1 shows the campus locations of UNAH.

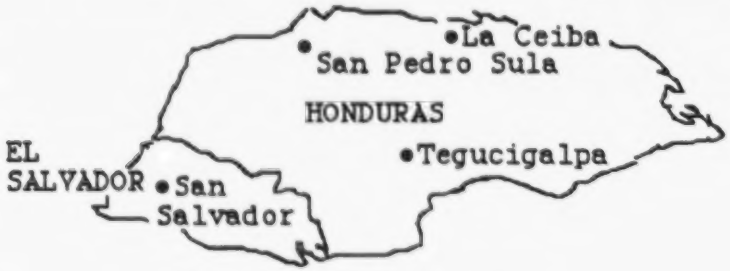

Figure 1. Map of Honduras

UNAH was established by constitutional mandate and is funded by approximately six percent of the national budget. This resulted in an annual budget for 1987 of nearly 30 million dollars. Students who attend UNAH are subsidized for their studies and pay a token matriculation fee of twenty-three dollars per semester. Faculty are mainly comprised of adjunct appointments, usually holding full-time employment during the day and teach late afternoon or evening courses.

The author was invited by the Secretario General[3] to visit UNAH's main campus to provide consultation on how to improve utilization of their computer facilities. The University had purchased an IBM 4361 mainframe computer in March of 1985 with the expectation that many of its administrative and academic functions would shortly be automated. Unfortunately after a period of two years only a few routine tasks had been transferred to the computer. As a matter of fact many of the jobs were taking twice as long because they were being performed both by hand and on the computer[4]! The utilization rate

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[1]The capital city of Honduras.

[2]The largest and fastest growing city in Honduras.

[3]This position is analogous to a Vice-President for Academic Affairs, though there are a number of differences from the U.S. counterpart. For example, in most U.S. institutions of higher education, this person is appointed by the President or selected by a committee (which is appointed by the President). In Honduras, this individual is elected by both faculty and students.

[4]Many of the jobs being performed both by hand and on the machine had been tested for over nine months. Full transition had not taken place because errors were routinely discovered whenever the program was run.

of the mainframe computer was running at only 5 percent of capacity. In many U.S. universities the utilization rates for administrative and academic computers run much higher (about 70 percent of capacity or more in some institutions).

Pre-site problem definition took place by correspondence. The author was led to believe that the transition to computer operations was being retarded by a lack of familiarity with administrative and academic software, training deficiencies in the computer center's support staff, and a series of mechanical problems. The self-report was consistent with earlier work done by Barquin (1973) in which he categorized Latin American nations according to their *potential* for the development of a computer industry. In his analysis, Barquin used four factors to derive a computer industry development potential (CIPD) index. These four factors included (1) economic (GNP, per capita GNP, growth rates, % GNP in "high technology" areas), (2) education (literacy rates, relative number of students enrolled in secondary school or above, level of technical education), and (3) technical (electricity produced, number of telephones per thousand, number of television sets installed, and level of computer usage). The resulting CIPD score was a prediction equation based on weights for each of the factors mentioned above. Scores ranged from a low of 9.16 (Haiti) to 76.42 (Argentina). Honduras was ranked second lowest (23.08) and was considered to have very little potential for the development of a computer industry. The CIPD score might also be thought of as a proxy indicator for how well computer technology will integrate into organizational settings within the country. Figure 2 shows the CIPD ratings of the Latin American addressed in the Barquin study.

In addition to the factors mentioned above, the Secretario General was particularly concerned about computerization of the registration process. Computer registration for the previous semester was marred when electricity to Tegucigalpa was interrupted (a common occurrence). Even though power was quickly restored, it took the Computer Center an additional 40 minutes to get registration back on-line[5]. During the 40 minute hiatus, a near-riot broke out due to the students' impatience with the technology. Students could see that the electricity was operational, but they didn't understand why it took so long to power up the computer and its associated registration software.

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[5]This is not an unreasonable accomplishment after the computer has undergone an uncontrolled shutdown.

Figures 2a & 2b. CIPD ratings for Latin American nations (Source: Barquin, 1973[6])

Computer Center Hardware & Software

The computer center hardware consists of the following components:

1-IBM 4361 (4 MB)
1-Systems Control Unit
1-650 LPM printer
7-120 CPS printers
2-570 MB magnetic disk drives
1-Tape Drive Unit
1-Control Console
23-3270 (series) Terminals
1-Terminal Control Unit
6-Modems (uninstalled)

The operating system is IBM's SSX/VSE, designed as a small system

[6]Key to countries-
ARG(Argentina),BOL(Bolivia),BRA(Brazil),CHI(Chile),Col(Columbia),COS(Costa Rica), CUB (Cuba), DOM(Dominican Republic), ECU(Ecuador), ELS(El Salvador), GUA(Guatemala), HAI(Haiti), HON(Honduras), MEX(Mexico), NIC(Nicaragua), PAN(Panama), PAR(Paraguay), PER(Peru), PRC(Puerto Rico), URU(Uruguay), VEN(Venezuela)

executive and is used predominantly for batch processing. For computer systems which have limited available memory, and/or run predominantly batch jobs, this system seems to perform well.

The computer center currently supports the following software under SSX/VSE:

SDF (Screen Development Facility)
Cobol (Batch and CICS)
RPG-2 (Batch)
FORTRAN-77 (Batch)
Assembler (CICS)
PL/1 (CICS)
File Transfer Program (Micro-Mainframe)

plus locally developed software. All of the programs with the exception of the locally developed software are products of IBM. The computer center supported no third-party software as very few commercial vendors write programs to run under SSX.

Data Collection

Data collected during this evaluation took place over a 25 day period from May-June 1987. Data consisted primarily of semi-structured interviews, budget examinations, a review of organizational structure, registration records, relevant documents, and on-site visits. Most of the twenty-seven interviews were conducted in Spanish and required the presence of an interpreter. Respondents consisted of individuals who were academic or administrative unit heads that represented (1) current users of the mainframe computer, (2) identified themselves as being potential users of the computer, or (3) were suspected of being potential users even though they didn't see access to the computer as a likely event. While most of the interviews took place in Tegucigalpa, a total of six were conducted at San Pedro Sula and La Ceiba.

Semi-structured interviews consisted of questions designed to elicit the following information:

1. For what tasks was the respondent's unit responsible?
2. What tasks were presently performed by computer, if any?
3. What tasks would the respondent like to have accomplished by computer?
4. What process was used to request that a task be computerized?
5. How long did the respondent expect transition to computerized operations to take?
6. What technical difficulties did the respondent experience with the

computer?

7. What was the organizational relationship of the unit to the computer center and to other units which were requesting similar tasks?

8. Did the respondent see any organizational changes that would facilitate integration of computer technology within the University?

9. What mechanism was in place to ensure that the respondent's unit had access to equipment and software?

Budget records included an examination of proposed and approved budgets for the University overall and by departments. Records were studied for the years 1985-1987. Organizational charts reflected the past and current organizational structure of the University. Both charts for the administrative and academic structures were inspected. Other relevant documents pertaining to the evaluation included descriptions of University administrative procedures, a description of how the IBM mainframe was chosen by the University, a proposal outlining organizational changes in the Secretario General's office, and technical manuals detailing hardware and software capabilities.

Registration records proved to be an interesting source of data. It seems that one of the major problems in the University is determining what course requirements a student has fulfilled. The problem originates with departments that (1) change requirements internally without notifying the registrar and (2) require certain courses during some years while during other years those courses are insufficient to meet the requirement. As a result, the departments maintains control over registration because only they are qualified to evaluate a student's academic record. One negative side effect of this arrangement is that when a student seeks re-admission to the University, the process of evaluation can take over a week.

On-site visits included trips to San Pedro Sula and La Ceiba. It was discovered during these trips that while UNAH had purchased equipment in 1985 for the satellite campuses, only the equipment for San Pedro Sula had actually been shipped from UNAH (though never installed). The equipment purchased for La Ceiba was still stored in Tegucigalpa. Moreover it was found that while the extension campuses were supposed to be relatively autonomous in their administrative activities, they were still dependent on the main campus for registration. The registrar was required to mail in student rosters to the central campus. Mail service was such that it would usually take two weeks for a registration to be confirmed. A major source of irritation for the students in San Pedro Sula and La Ceiba was that the procedure for adding and

dropping a course in the current semester could extend well until the *subsequent* semester because of the delays involved in forwarding University registration materials.

Problem Redefinition

It became clear after the first few interviews that the problem as originally defined was in fact not the critical impediment for the integration of technology at UNAH. Technology-based problems were restricted to three primary areas: (1) lack of a universal power system (UPS) to serve as a back-up power source during the frequent electrical outages, (2) lack of a communications mechanism to the auxiliary campuses and (3) lack of a computer operating system which supported third-party commercial applications The computer center staff were acutely aware of the first problem and had developed a strategy for selecting a UPS system. They were also acquainted with the second problem and were evaluating several solutions. The third technological problem was less apparent, but a choke-point for expansion of system services. This last problem directly related to the much larger challenge: *changing the philosophy on how the computer is used and the responsibility for who uses it.*

In order to address these operating issues more fully, it might be useful to quickly review the development of the computer industry.

Development of the Computer Industry

Development in the computer industry has changed drastically over the last three decades. Figure 3[7] may serve to demonstrate just how rapidly the computer is evolving:

The batch computer of the 60's required that keypunched cards be used for the input of data and commands. The term "batch mode" is often used today to indicate this process. Control of the "batch mode" computer is typically very restricted. For example, a computer center director may decide that priority for a given period of the day be given to administrative operations. The director may stipulate that no batch jobs for academic work may be run during these times. By regulating in this manner, the director essentially establishes an operating philosophy which implies (1) centralized control and and (2) restricted access. A number of writers have suggested that this type of control was exerted over users as a way to "professionalize" the computer industry.

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[7]This evolutionary model was adapted from: Daniel Atkins, PhD., Associate Dean and Professor of Electrical Engineering, College of Engineering, The University of Michigan.

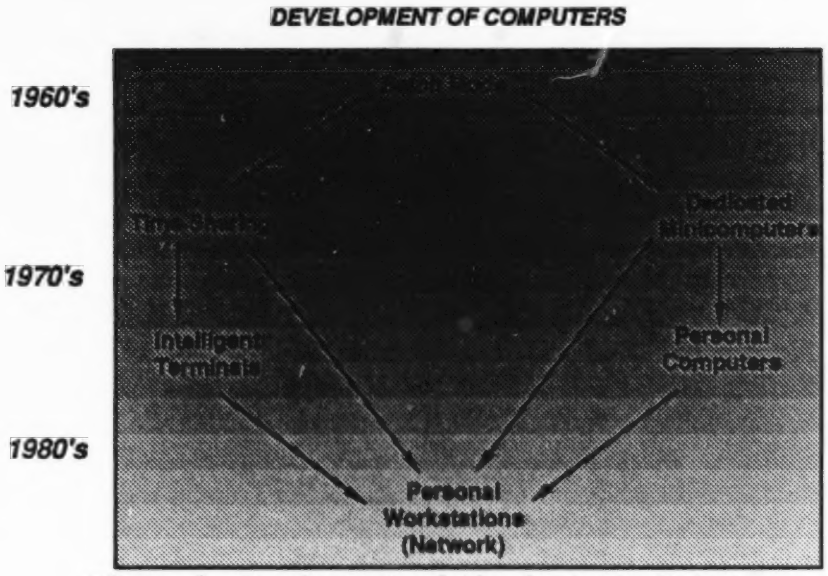

Figure 3. Development of the Computer Industry

The late 60's and early 70's brought about the parallel development of timesharing and dedicated minicomputers. The large centrally-based mainframe computers on many academic campuses and intermediate school districts were often replaced by several minicomputers. Small academic and administrative departments found minicomputers to be affordable enough to purchase, maintain, and operate. Timesharing involves direct interaction with a terminal in place of reading batch cards. Input and output are routed to a user's terminal while all terminal users "share" the computer's time through a process known as *time-slicing*.

Interactive use of the computer and dedicated minicomputers signaled the decentralization of computer operations in the computer center. No longer was it necessary to wait for the computer center's approval to install and run software. The individual user could easily do it with little or no intervention from a computer expert. Moreover operating systems which supported interactive terminal access spawned third-party commercial software. Software developers have subsequently generated programs to support a number of applications in higher education administration. Applications include software for: planning, management, and institutional research; financial management applications; general administrative service applications, auxiliary service applications; logistics and related services; physical plant operations; admissions and records applications; financial aid administration; library applications; hospital applications; other applications (e.g., alumni

records, testing scoring and analysis, etc.)(Thomas, 1979).

Starting in the mid 70's and in more recent times, computer industry observers have witnessed the tremendous growth of the microcomputer. Microcomputers might be thought of as the most decentralized control of access to computer resources--control at the individual level. With the advent of personal computers even more third party software support flourished. For example, the Apple II, a ten-year old microcomputer, has the most widely distributed operating system and more programs written for it than any other computer (mainframe, mini, or micro) marketed.

One of the prices paid by users for decentralized control of computer resources is a relative lack of support for third party software by the computer center. Unless the computer center hires a large technical staff, it would be impossible to maintain and sponsor all the written software for a given mainframe, mini-, or micro-computer. Third party vendors attempt to counter the lack of computer center support by writing software which is comprehensive and easy to use.

The process of decentralization has not been fought without battles. The advantages of a distributed approach to operating a computer center, however, have been straightforward. Because computer center staff had control to access in a centralized operation they exerted a *great* power but over a *small* group of users. With decentralized control, they exerted *less* power but over a *larger* group. This is analogous to the "big fish in a small pond" versus "medium size fish in a big pond" situation. In the mid 70's most computer centers migrated to the "big pond"/decentralized approach to serving users. This allowed the computer center to fulfill its primary mission while at the same time maintain its relative status within the organization. *Application and system software written since that time have reflected this philosophy.* Computer centers run in a decentralized fashion have often been referred to as "information centers."

Recommendations for Decentralization

The greatest problem in this evaluation was convincing the client that their utilization problem was not founded in technology, but rather in organizational structure and operating philosophy. Many stakeholders had a vested interest in maintaining the status quo with respect to organizational structure. Moreover the organizational structure which might be affected by the recommendations were often *elected* offices. This meant that the time frame for organizational change would be much longer than it might be if the office had been appointed.

Organizational Structure

The proposed re-organizational structure is outlined in Figure 4 and reflects a staffing level approximately 2 1/2 times the size of the current computer center staff. The organizational structure is considered a skeletal for a 24 hour/day operation (i.e., currently the UNAH computer center operates 12 hours/day).

The major change of this organizational structure has to do with re-alignment the computer center director's responsibilities[8]. These responsibilities were too diverse and demanding for any one individual to perform. Rather, functions required for efficient operation of computer operations should be distributed to individuals with a direct interest in seeing that the work is completed. The previous organization specified that the computer center director make decisions on matters that were not linked to his immediate responsibilities.

The following managerial positions reflect a more decentralized administrative structure and are generally consistent with structures found in the U.S. (Mann, 1979):

V.P. for Information Systems. The Vice President for Information Systems is responsible for all aspects of computing operations for UNAH and the auxiliary campuses in San Pedro Sula and La Ceiba. His/her main task is to plan, budget, and administer computer center operations, purchase academic and administrative software, and acquire microcomputers for the various units on campus. He/she reports directly to the Rector and is responsible for publishing the computer center newsletter to University administrators, faculty, and students. This is a full-time administrative appointment.

Computer Center Director This individual is responsible for the day-to-day operations of the computer center. His/her main task is to ensure that all components of the system operate smoothly and efficiently. S/he develops a budget in conjunction with the Vice President for Informations Systems which reflects trends in computing activity at UNAH. In addition, s/he works with central administration to develop a computer allocation budget which reflects how much each department/unit will receive in computer service funds. People under his/her supervision are responsible for the administration of computer accounts, intra- and inter- campus computer communications, system repair and maintenance, and normal computer center operations[9]. This is a full-time

[8]An interim computer center director was in place at the time.
[9]Three shifts would be required for a 24-hour operation.

administrative appointment.

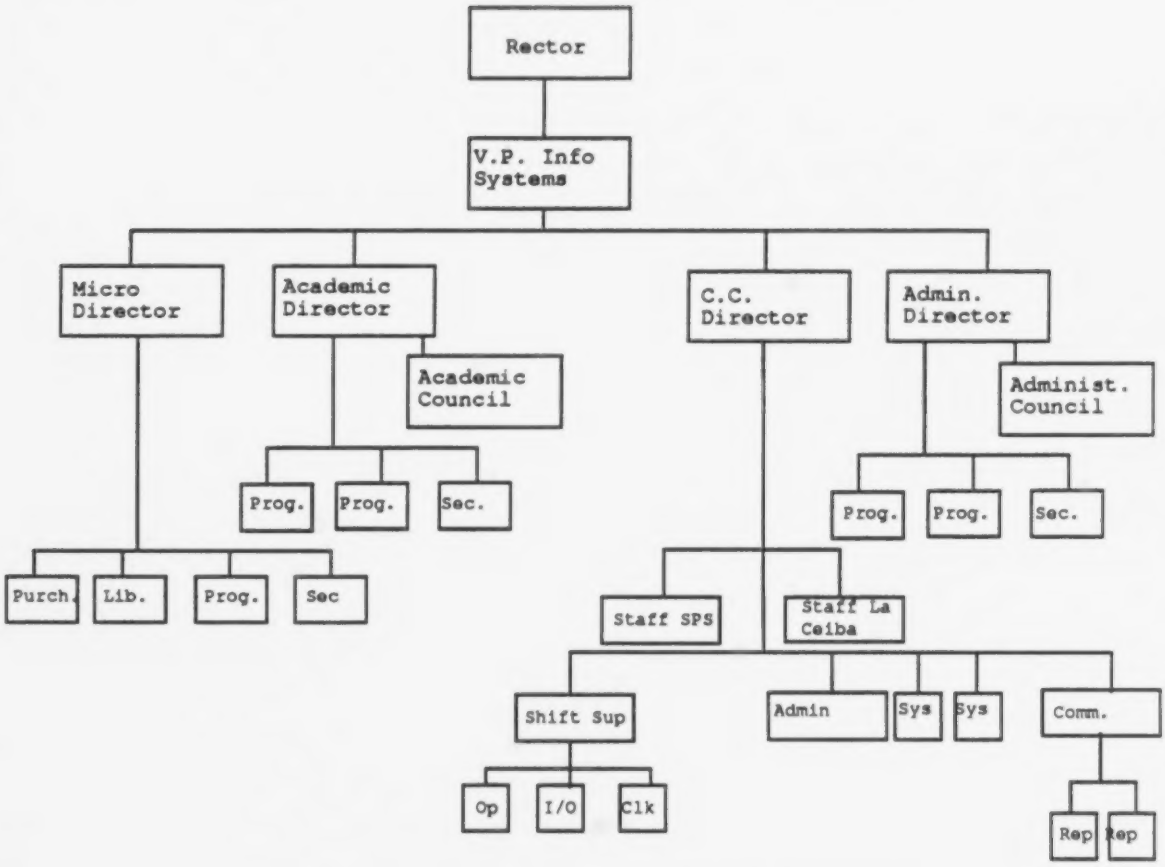

Figure 4. Proposed Organizational Structure

Academic Director This individual is responsible for planning and budgeting academic software acquisitions for the University. His/her budget is allocated by the Vice President for Information Systems. S/he works closely with the Academic Software Committee to enumerate and prioritize desired software. At least two programmers are allocated to this office for the development and implementation of academic software. S/he is responsible for identifying and training software package 'experts' to support purchased or developed software packages. S/he is also responsible for scheduling training on acquired software packages. This is a half-time administrative appointment.

Administrative Director This individual is responsible for planning and budgeting administrative software acquisitions for the University. His/her budget is allocated by the Vice President for Information Systems. S/he works closely with the Administrative Software Committee to enumerate and prioritize desired software. In addition, s/he is responsible for the design and

implementation of the relational data base used by the various administrative offices on campus. At least 2 programmers are allocated to this office for the development and implementation of administrative software. S/he is responsible for identifying and training software package 'experts' to support purchased or developed software packages. S/he is also responsible for scheduling training of acquired software packages. This is a half-time administrative appointment.

Microcomputer Director This individual is responsible for planning and budgeting microcomputer acquisitions for the university. His/her budget is allocated by the Vice President for Information Systems. S/he works closely with industry to negotiate the best microcomputer hardware and software purchases for the university. S/he maintains a library of demonstration and public domain software. His/her counselors provide both software application and limited programming support. S/he works closely with the Computer Center Director and Communications Manager in installing microcomputer facilities on campus so that they can also serve as terminal facilities. S/he maintains an office where microcomputers can both be demonstrated, purchased and repaired. S/he is also responsible for scheduling training of acquired microcomputer software packages. Initially this may be a half-time administrative appointment, but within three years should become a full-time administrative appointment.

In addition to the managerial descriptions described above, the organizational chart reflects the formulation of two Software Committees. Academic Software Committee. This group is composed of representatives of the various academic units at UNAH and the extension campuses at San Pedro Sula and La Ceiba. These individuals are appointed by the various Department Heads and report directly to the Academic Director. Their job is to help the Academic Director identify and prioritize the academic software to be purchased/developed in a given budget cycle. In addition they may offer suggestions as to future computing directions at UNAH.

One of the important functions of the committee would be to generate a 2 year master plan of software purchases and/or software development projects. It is important for every department head to estimate approximately when the computer center intends on handling their problem (program). For example because of higher priority demands, it may take some time (e.g., over a year) for a given department to get programming resources under normal budget constraints. Nevertheless it is important for the department head to be able to plan for that program development as he/she may have to provide internal

personnel to detail the specifics of the program. This process should be published and updated once a quarter so that department heads can see how computer center resources are being expended. Priorities assigned to different projects could only be changed by the Academic Software Committee.

Administrative Software Committee This group is composed of representatives of the various administrative units at UNAH and the extension campuses at San Pedro Sula and La Ceiba. These individuals are appointed by the various Unit Heads and report directly to the Administrative Director. Their job is to help the Administrative Director identify and prioritize the administrative software to be purchased/developed in a given budget cycle. In addition they may offer suggestions as to future computing directions at UNAH. Their other functions are similiar to those outlined for the Academic Software Committee.

Within the computer center, two new positions were proposed. One was an administrative position; the other an operational position.

Account Supervisor. This individual is responsible for account administration at UNAH and the extension campuses at San Pedro Sula and La Ceiba. His/her main task to allocate and monitor computer service funds to all computer clients. S/he issues monthly reports to all department/unit heads and the university's private clients. S/he arranges for limited-time accounts for students required to use the computer as part of their normal classroom experience. S/e works with the Computer Center Director to develop realistic computer service allocation budgets.

Communications Supervisor. This individual is responsible for all aspects of computer communications at UNAH and the extension campuses at San Pedro Sula and La Ceiba. His/her main task is to oversee the installation of computer terminals, the purchase of communication's controllers, computer modem installation, and the development of departmental local area networks. In addition, s/he is responsible for the maintenance of the communications links among UNAH, San Pedro Sula, and La Ceiba.

The other positions detailed in the organizational chart corresponded to existing job descriptions. The only change had to do with the number of positions listed which had been increased to reflect an increase in the number of hours the computer center would be open.

Operating Philosophy

While recommendations concerning organizational structure were unlikely to be implemented in the short run, it was possible to make technological recommendations that would ultimately have organizational implications. Recommendations focused on steps the University had indicated a readiness to

take.

Some of the recommendations involved purchases that the University would have to make. It was noted that the purchases would have to be budgeted, and that the budgeting process is more democratic in Honduras than in most U.S. institutions. The Secretario General and computer center director would ultimately have to advocate the purchase of many items to the University's General Council.

Operating system. If the computer center's activities were to be expanded beyond batch use, it was recommended that the computer center acquire an interactive operating system such as VM/CMS (Virtual Machine/Conversational Monitor System). With VM/CMS, up to 256 users can be supported on the IBM 4361 in interactive mode. The interactive timesharing environment would be conducive to independent use of the system by both administrative and academic users.

One major concern in converting from one operating system to another centers around the cost and amount of work required to make the conversion successful. In order to run VM/CMS the computer center would first have to effect two hardware changes. The IBM 4361 required an expansion of memory to at least an IBM model 4361-M04 (8M). A second upgrade entailed the purchase of a new DASD 3370-A01 unit. The new DASD unit would contain the actual VM/CMS software and runs on a line separately from SSX, the existing operating system. The university would run dual operating systems until it made a full conversion to VM/CMS.

Another reason for exploring the use of VM/CMS was that in addition to its ease of use, the operating system supports a very large library of third party developed software. With VM/CMS, the university could purchase/lease commercial software such as statistical analysis packages (e.g.,SAS or SPSS-X), budgeting packages (e.g.,System W), or Data Base applications (e.g.,SQL). Moreover an impressive array of IBM packages would also be available to t system users (e.g., PASCALVS).

It was further recommended that the responsibility for deciding which software to purchase might rest both with the Academic & Administrative Software Committees. Each committee could in turn conduct a needs assessment for their respective units. For example, the Academic Software Director could poll the various departments to discover what software each department wants, how much they intend to use the software, and for what other auxiliary activities the software might be appropriate. The Director could go back to the committee and prioritize the desired software, then purchase it from the

Comittee's existing budget.

Consequences for Change in Operating Philosophy

By increasing access to the operating system, the computer center could explore alternative methods of cost recovery. Two suggestions were made in the evaluation:

The Computer Center as a Profit Center In addition to implementing a new operating system, it was suggested that the computer center install an accounting system. The purpose for doing so was two-fold: (1) to document how much the computer is being used and by whom, and (2) to devise a system of cost recovery. The rationale for utilizing this approach was simple: (1) fiscal accountability should result in a more efficient running of computer operations, (2) those units which demand the most attention will get it (but at a cost), and (3) documented computer activity will lead to realistic future budgeting.

Two difficulties are usually associated with implementing a "charge back" procedure. These include problems with (1) setting rates for the computer services, and (2) developing realistic computer service budgets for each unit.

While no perfect solution exists to establish computer service rates, some guidelines might be considered. In developing reasonable computer service rates, one could look to industry for some general direction. How much do industry vendors charge per CPU hour, for disk storage, or for an hour's worth of programming time? Alternatively one might look at a regional university to examine their practices in rate structuring. Rates might be adjusted upward or downward to reflect the actual overhead of the University and the degree to which the University desires to be competitive.

In determining a unit's initial computer service budget, one might examine the average ratio of the unit's utilization history and multiply that average by existing (or proposed) service rates. It was anticipated that some adjustments could be expected during the first year of operation. After an initial adjustment period, however, it was recommended that service rates and unit allocations only be modified by a budget transfer from a unit to the computer center or by the direction of the Rector.

Entrepreneurial Activities of the Computer Center. Access to additional sources of funding was a major problem for the computer center. One possible alternative was for the computer center to initiate revenue-generating projects in order to supplement University-administered funds. In the U.S., many universities prohibit competition with local industry, but in Honduras no

such prohibition exists.

Once the university had purchased a minimal configuration of third party software, it might consider offering the use of the software for a fee to vendors outside the university, The Director of Research might be in charge of coordinating this fee-based activity. S/he would be responsible for recruiting government, business, and industry to solicit their interest in using the computer services of the university.

Inter-and Intra-Campus Communications

Increasing access to the computer software required at a minimum access to the system. A number of suggestions were directed towards increasing physical access to the computer. In addition, general communications/public relations issues were addressed. These included the following recommendations:

Communications with San Pedro Sula and La Ceiba. In order to make use of the computer equipment at both San Pedro Sula and La Ceiba, it was recommended that the University consider renting a 'dedicated' phone line to both auxiliary campuses. The cost of renting a 'dedicated' line to San Pedro Sula was approximately $1300/month[10]. Alternatively, renting a 'leased' line would run about $60/hour. Renting a 'dedicated' line was preferable to a 'leased' line because communication costs could be recovered after only 22 hours of use/month. It was anticipated that usage levels would surpass the cutpoint after 2-3 months of operation and training. Moreover the quality of 'dedicated' lines tend to be higher than that of 'leased' lines. Finally the types of modems already installed were configured for dedicated operation.

Achieving operational status for the computer centers at San Pedro Sula and La Ceiba would result in a number of advantages. First, it would provide a continuous communications link to the main campus in Tegucigalpa. Second, it would allow for more decentralized operations. Finally making the San Pedro Sula and La Ceiba computer centers operational would permit faculty and students access to programming and educational software

Dial-in Service. In order to increase utilization of the computer by academic members of the University, it was recommended that the computer center consider installing a dial-in service. The dial-in service would give a faculty member, student, or other client access to the computer from remote locations (e.g., home or industry). As the computer system was set-up, only synchronous operations were possible.

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[10]A line will service about 16 terminals. The cost for a dedicated line to La Ceiba was slightly more. At the time of this report $1.00=2 Limpirias.

To set up a remote service would required three steps. First the University would have to purchase an IBM 7171 protocol converter to handle asynchronous ASCII terminal input and translate it into IBM EBCDIC synchronous protocol for use by the IBM 4361[11]. Second the University would have to buy auto call-answer modems to handle a reasonable number of dial-in lines. Sixteen such lines might be considered initially, though once this service is publicized demand would most likely increase at a rapid rate. Finally the University would have to install phone lines to accommodate this new service.

There are a number of advantages to establishing a dial-in service. First the service would allow remote access to the computer center's hardware and software facilities. Second, the dial-in service would encourage integration of microcomputers with the mainframe service. If the University can promote the expanded use of microcomputers, then the 'shelf-life' of the IBM 4361 could be extended. Finally, establishing a dial-in connection would allow the University to contemplate computer connections with other regional institutions so that messages, data, and files could be transferred between collaborating faculty and administrators.

Communication with the Rest of the University. One of the implicit responsibilities of the computer center is to communicate with clients (units, administrators, faculty, and students) concerning its progress, problems, acquisitions, and personnel changes. In addition, it should regularly publish a schedule of hours, a listing of special computer classes, etc. This responsibility is important because if the computer center is to compete for limited university resources, it must demonstrate that those resources are spent efficiently and wisely. Otherwise units have no basis for making informed judgements about the performance of the computer center. If the units are impressed with the computer center's performance, they might be supportive of budget increases for the computer center. In addition, when asked, units usually have good ideas about the future steps that the computer center can take to improve its operation.

In this vein, it was recommended that the computer center consider establishing a Computer Center Newsletter. In the newsletter, the computer center could disseminate changes, new programs, and other items of interest. As a dissemination vehicle, the newsletter would serve a number of purposes: (1) to keep clients aware that the computer center is working on projects of

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[11]Most commercial terminals are ASCII-based. Almost all commercial modems are asynchronous.

concern to them, (2) set reasonable expectations about what the computer center can and cannot do, (3) give a general time frame about when to expect system/software changes.

Personnel Recommendations

No specific personnel recommendations were made other than recommending a new organizational structure. However, there were general concerns which required attention on the part of the computer center.

Training. The issue of adequately trained personnel was thought to be critical for a successful computer center operation. Without qualified personnel, it is impossible to operate machinery or provide a quality level of service. However, training should not be limited to maintaining status quo operations, but rather as a mechanism for improving and altering ervices as user demands change.

The recommendations for training activities were subdivided into three areas: computer center immediate actions, University immediate actions, and computer center/university long term actions.

Computer Center Immediate Actions. The computer center was asked to consider sending two individuals with appropriate backgrounds to the United States or Europe for master's degree training in computer science with a subspeciality in either (1) computer hardware design or (2) operating systems (software development). The universities to which these individuals might apply should be chosen on (1) the strength of their academic programs and (2) their similarity of computer systems to the IBM 4361 (and/or the installation of VM/CMS).

After acquiring their training, these individuals would return to UNAH and assume mid-upper level management positions (e.g., Communications Supervisor, Microcomputer Director) at the computer center for a minimum term of 4-6 years. Their main collateral responsibility, however, would be the internal training of computer center staff. In addition some thought was given to appointing these individuals on a part-time basis to the faculty in the proposed department of Computer Science. The function and operation of this new department is described below.

A second step that the computer center was asked to consider was to provide more extensive internal training to already existing staff members. IBM offered (or could offer) this training so that staff could become more knowledgeable about operating systems and third-party software.

University Immediate Actions. Once the computer center staff had been thoroughly trained on the new operating system and third-party software, it

would be useful to choose a select number to serve as trainers for University computing clients (e.g., administrators, faculty, and students). These 'tutors' would be qualified to provide instruction for a number of 'short courses' (e.g., 1-2 days duration). Use of the 'tutors' would help to quickly expand the base of knowledgeable clients and to orient more of the University community to activities involving the computer.

Computer Center/University Long Term Actions. It was recommended that the university consider creating a new department of Computer Science. Specialists graduating from this department could be hired internally or be assimilated into the Honduran business community as the economy permitted.

Initially the new department might evolve from a program within the Mathematics Department[12] with cross-disciplinary curricular support from Physics, Electrical Engineering, and Library Science. The new program would act both as a service unit, providing structured programming courses (e.g., Pascal, C) to external programs (e.g., engineering, economics, business, library science), and as a way to develop a limited number of individuals with specific hardware and software expertise.

It was expected that instructors for this program would initially be drawn from across campus departments. However once the program was established, faculty would be hired to primarily serve the program. As a solid group of individuals emerged, it was recommended that this unit be re-formulated into a Computer Science Department.

Establishing a Computer Science Department would serve a number of functions. First it is a logical outcome of research and development in the computer field. Second it would foster the development of expertise at the University in this domain. Finally it would demonstrate to government, business, and industry that the University was responding to technological changes which may have an effect on the Honduran economy.

Recommendations Having to Do with Physical Changes to the Computer Center

Some of the technological recommendations included improvements to the physical plant. These included:

Increased Physical Space for the Computer Center. The first recommendation in this area addressed space restrictions to the computer center. The space allocated was far too small for the efficient operation of the center.

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[12]In my discussion with faculty and administrators, the Mathematics Department was unanimously identified as having individuals with core expertise and interest in this area.

Moreover there were significant electrical and fire hazards which required immediate attention.

Universal Power Supply & Voltage Regulator. One of the unique problems in operating a computer center at UNAH has to do with irregularities in the Honduran electrical power system. I was able to observe over 5 blackouts during 20 days on campus. One blackout lasted over 15 minutes. Upon further investigation, it was discovered that blackouts occur about 3-4 times a week with an average duration of 5 minutes. Apparently because of the unreliable nature of the electrical power system, it is not possible to predict when these blackouts will occur and how long each one will take.

While the computer center has its own separate electrical supply line, it is nevertheless was subjected to unexpected blackouts. The separate line simply ensured a more regulated voltage supply. All of the blackouts required a cold restart (uncontrolled shutdown) of the computer system and its associated testing, a process which typically lasts about 45 minutes. In contrast, an emergency shutdown procedure can take as little as 4 minutes with a cold restart (loss of electricity after a controlled shutdown) in about 20 minutes. A controlled shutdown with a warm restart (no actual loss of electricity) can be effected in about 7 minutes.

Exposure of computing machinery to repeated uncontrolled shutdowns is an invitation to disaster. Not only do clients risk the loss of valuable data to programs (which can result in output errors), but damage to the machinery as well. At greatest risk are the disk drives which can "crash" and destroy the physical drive as well as the disk drive heads. Replacement of these units is usually expensive, time consuming, and risky because of the associated loss of changes since the last tape backup. It is a tribute the durability of the machinery that no "crashes" had occurred to date.

It was recommended that the computer center purchase a universal power supply unit with a minimum 10 minutes worth of battery backup power. A universal power supply unit immediately detects the loss of electricity from its normal source and provides an alternative source of power until the normal source is restored or until the alternate source is depleted. A supply unit of this type usually consists of banked battery packs which would have to be stored in a ventilated room separate from the computer center. Some units come equipped with a diesel generator which can supply power once the battery power has been depleted. These latter units tend to be expensive and require regular maintenance.

A minimum ten-minute unit was recommended because the average loss of

power lasted about 5 minutes.. If electricity was not restored within the 5 minute period, there would still be time to proceed with a controlled shutdown (about 4 minutes). Moreover, if electricity was restored during the controlled shutdown, the computer could complete the shutdown cycle and then be switched to a warm restart. Loss of computer service would then be limited to about 11 minutes.

General Software Recommendations

Establishing Data Bases for Administrative Activities/Campus-wide Word Processing. One aspect of the computer center's operation which the author was specifically asked to address had to do with specifying steps to establish a University-wide data base (or data bases) and word processor.

Data Bases. In order to establish a University-wide set of data bases, it was recommended that the University and computer center take the following steps:

1. Purchase a generalized data base package to work under VM/CMS. IBM supports SQL, though other generalized data base packages are available. More specific data base packages have been written (e.g., for registration, grades, payroll, accounting), but these are exclusively in English and assume that the University is operating according U.S. conventions (UNAH had numerous exceptions to these conventions).

2. Under the guidance of the Administrative Director, the Administrative Software Committee would design the appropriate data bases and associated data tables. They would work closely with a SQL (or other data base) expert in conceptualizing the data base(s). It was recommended that the Administrative Director should be an individual who was intimately familiar with all administrative aspects of the University. The Administrative Software Committee should be composed of representatives from all administrative units who plan on using the data base. Both the Administrative Director and Administrative Software Committee members should be trained on how to use the data base software prior to designing its structure.

3. After the data base has been designed, the SQL (data base program) expert would help the Computer Center Director transfer information from already existing files to the data base. Responsible departments will input the information where it cannot be supplied from existing data files.

4. All departments will manually check the data base to ensure that information placed in it is correct.

5. The SQL (data base program) expert will aid department representatives in generating required reports.

6. Unit heads check the accuracy and completeness of reports.

7. Data bases and relational tables are tested in an appropriate cycle (e.g., one month, one quarter, one semester) prior to operationalizing the system. Changes are made by responsible departments in conjunction with the data base expert to the data base structure or reports.

Word Processing. Rather than purchase new terminals, it was recommended that the University consider purchasing microcomputers. These devices could act both as stand-alone computers and as computer terminals attached to the mainframe. As a stand-alone machine, the microcomputer could be used for word-processing, spreadsheet analysis, graphics creation along with a number of other functions. If documents required transfer to another office, the documents could be sent via the mainframe computer and 'punched' to another individual's account through VM/CMS. It was noted that if the University decided to follow these recommendations, third party packages should be purchased which could be distributed to *all* administrative offices

Dual functionality of microcomputers presents several advantages. First, the University would be able to stretch limited resources further. Terminals have only one function, microcomputers have multiple functions. Second, microcomputer software tends to be easier to use than mainframe software. Because of this it would be easier to train administrative personnel how to use the computer. Finally, by using the microcomputer for operations such as word processing, CPU demand for the IBM 4361 would be diminished thus maintaining good response time for those who actually need to use mainframe capabilities.

Advocacy Role by the University

The last evaluation recommendation invited the University to reassess its role in directing the future of technology infussion within the country. As a national University it was not unreasonable to believe that the institution could help shape national policy. One step that was recommended was to take on an increased advocacy role in the promotion of computers and computer-related issues. For example, Honduras taxes computers and peripherals as luxury items (e.g., as automobiles are taxed) rather than as educational tools (e.g., calculators)[13]. Despite that fact that the imposition of a tax may bring about some income to the country, it is nevertheless discouraging the expansion of computing activity in Honduras.

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[13]While discouraging the importation of cars makes some economic sense (e.g., the cost of importing fuel and building roads is considerable to the domestic economy), there are no associated costs for importing computers other than the actual loss of currency for the machinery itself.

This makes Honduras less competitive in the business and industrial economy.

The University was in a unique position to influence legislation to change the tax status of computers/microcomputers and might consider taking pro-active steps to do so. A change in the tax status for computers was successfully advocated by the national universities of both Costa Rica and Guatemala. As a result, expansion of computer-related activities in those countries has occurred.

Advocating a change in the tax status for computers/microcomputers would derive three major benefits. First, as mentioned above, the change in tax status would most likely result in increased computer-related activity. Second, more students and faculty would be able to afford computer equipment and defray some of the University's costs by purchasing the equipment themselves. Finally, the university's budget for computer equipment could be stretched by 30-50 percent if it did not have to pay such high taxes on the machinery and software.

Conclusions

This evaluation has demonstrated that the introduction of computer technology is not complete unless it is integrated to all domains linked to the technology. A simple example will perhaps highlight these dependencies. A newly built automobile will run if given sufficient gas and oil. But it will only run for *a while*. As most western consumers well know, after its initial test drive, the automobile demands a good deal of attention. The use of an automobile requires support in terms of maintenance, parts, inspections, insurance, and regulation not to mention the construction of roads, bridges, and tunnels. The support system and dependencies for automobiles are so well integrated that we may well forget about them (unless of course its midnight and you're trying to find a mechanic to work on your stalled vehicle).

Support systems for computer technology are less distinguishable, but present. In this particular evaluation, problems were identified in the areas of organizational structure, operating philosophy, budgeting, training, and the allocation of physical space. Each of these structures required some modification to promote the infusion of technology in addition to the installation of hardware. The costs for implementing the support structures, both economic and political, will most likely outweigh the technology costs. Because the support functions are so critical in completing a transition to computer use, analysts in this area must become familiar with the sociology/psychology of computing in addition to developing their technical expertise.

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